US NAVY WATER INJECTION SYSTEM

Driven by the desire to improve the capability to lighter grounded vessels, such as the freight vessel NEW CARISSA, the U. S. Coast Guard (USCG), in partnership with the U. S. Navy Supervisor of Salvage (SUPSALV) and industry, designed, developed and tested a prototype viscous oil pumping/off-loading system. The core of the system is a water injection annulus flange mounted on the discharge end of a Desmi DOP-250 positive displacement screw pump. The annulus delivers a small amount of water (approximately 5 % of the oil flow) at high pressure into the oil stream. The water "ring" that is created reduces the friction between the highly viscous oil and the pipe, or hose wall. This friction reduction significantly reduces the large pressure losses incurred during viscous oil lightering operations.

Two variations of the annulus were tested. The original annulus used was manufactured to DIN standards and donated for testing by FRAMO of Norway. A redesigned version was fabricated by Global-PCCI, JV under contract to USN SUPSALV and the USCG HQ. The new design was fabricated so that it would meet U.S. ANSI standards, and improve the flow characteristics of the water path. The other changes in the new design were in flange size, orifice dimensions, the addition of a water diversion ring, and a change in the material from steel to structural grade aluminum.

The FRAMO annulus was tested in Seattle, Washington (September, 1999), and both annuli were tested at the Oil and Hazardous Materials Environmental Test Tank (OHMSETT) Facility in Leonardo, NJ (November 1999), with excellent results. A third test was conducted at the OHMSETT facility in March of 2000 using centrifugal pumps and steam injection with viscous oil. The emphasis of this batch of testing was to compare centrifugal pumps in light to medium viscous oil. The VOPS system was only used in one round of testing.

Test results from the September and November 1999 workshops proved that a small amount of water, circumferentially injected into an oil transfer system, is capable of dropping discharge head pressure by ratios of greater than 10:1.

The highlight of the testing was the verification that the prototype water injection system (formerly called the VOPS) could transfer oil in the 17,000 cSt viscosity range through US NAVY 6 inch floating hose system over a distance of greater than one quarter of a mile. The pumping was done at a flow rate of 450 gallons per minute and a head pressure of less than 90 psig. With out the use of annular water injection techniques, one would have had to over come a head pressure of approximately 870 psig wit the same oil and transfer system.

By reducing the discharge pressure in a piping system, the off-loading, or oil transfer team is able to push heavier (more viscous) oils, and or push light oils longer distances with-out increasing the quantity or size of the discharge pumps.

From these workshops and tests, we have been able to improve the viscous oil pumping capability of U. S. Navy, U. S. Coast Guard and industry at minimal costs and without significantly increasing existing inventories. The addition of annular water injection allows the operator to increases both the pumped volume of very viscous products as well as the distance they can be pumped. Full pumping rates of 100 m³/hr and higher were achieved with oil in the 17,000 cSt range out to 400 meters (1300 feet) of hose, using a very small amount of injected water (varying between 4% and 6% of the oil volume). Prior to this development heavy oil pumping was restricted to very short pumping distances. Future developments in this system in the form of pump technology and system procedures will further the enhancement of the US NAVY and USCG Pollution abatement and Salvage response systems.

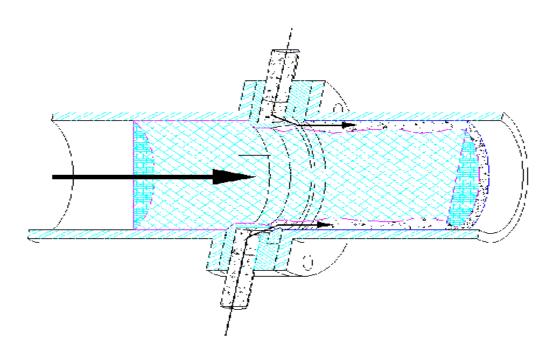


Figure 1. Internal view of annular water injection flange in operation

The diagram in Figure 1 depicts the internal theory behind annular water injection technology. The large black arrow shows the pumped fuel path up through the pipe. The small arrow traces the entrance of the small amount of water into the injector flange. The water can be seen forming an internal coating "water ring" on the inside of the hose.

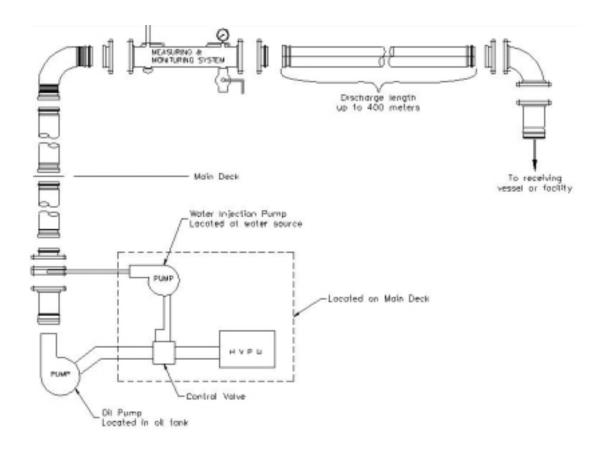


Figure 1. The Viscous Oil Pumping System VOPS annular water injection based pumping technology.



FIGURE 2. Testing in progress, MMS OHMSETT employee (foreground) records system pressure as ESSM and USCG Personnel (background) operate and record system flow rate and hydraulic controls while pumping oil with ESSM pump systems. OHMSETT NJ MARCH 2000.



Figure 4. USN ESSM and USCG personnel rig a USCG Centrifugal Submersible water pump for oil testing in March 2000, at the OHMSETT Test facility in Earle NJ.